Mr. Davis
Algebra II

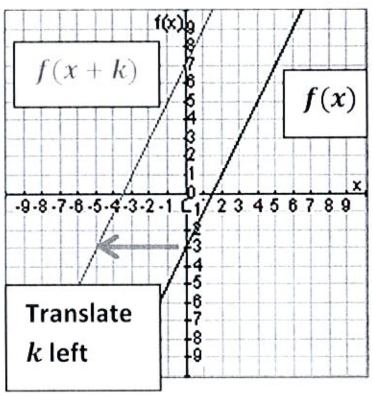
April 13, 2015
Transforming Exponential Functions

Name: ______________________

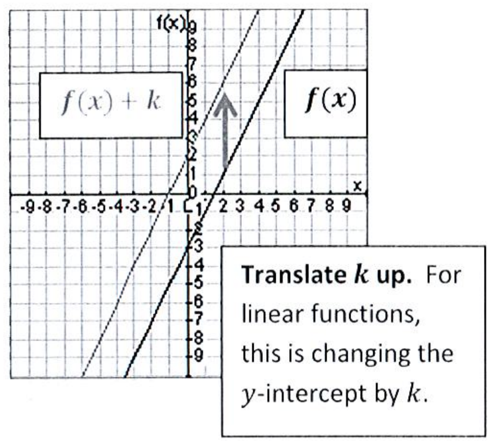
4.3 Transforming Exponential Functions

In our discussion of linear functions we learned about four transformations in equation form. We found that by adding a value either to the input or output of the original function we could translate the function left/right or up/down. We also found that by multiplying either the input or output by a value we could push towards or away from either axis. Here's a brief review through the lens of linear functions.

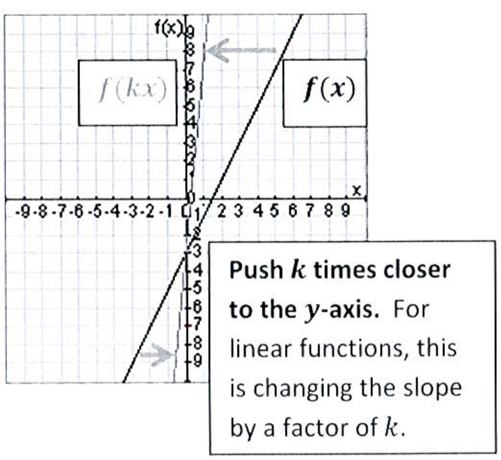
$f(x+k)$



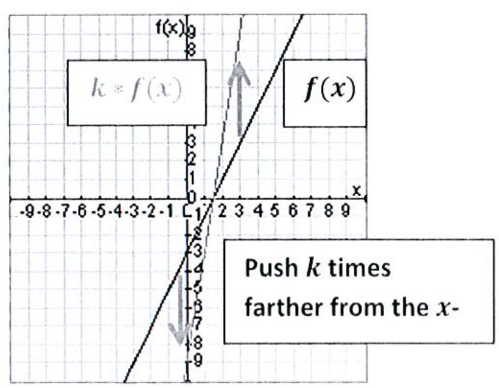
$f(x)+k$



$f(kx)$



$k * f(x)$

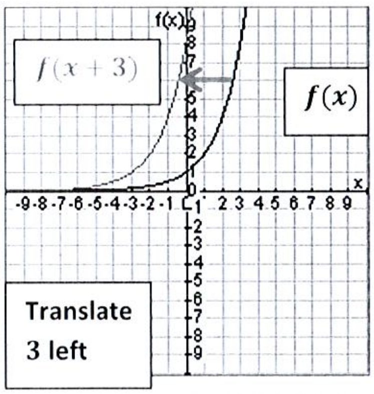


For linear equations which always have the form $y = mx + b$ this boils down to either a change in slope (rate of change), a change in the y-intercept (initial value), or a combination of both. Let's look at how these same equation transformations affect exponential functions.

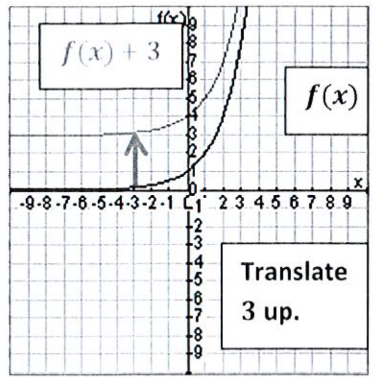
Transforming Exponentials

For the next few graphs, we'll use $f(x) = 2^x$ as our **parent function.** The parent function is the pre-image of our transformation. It's what we are comparing the transformed function to.

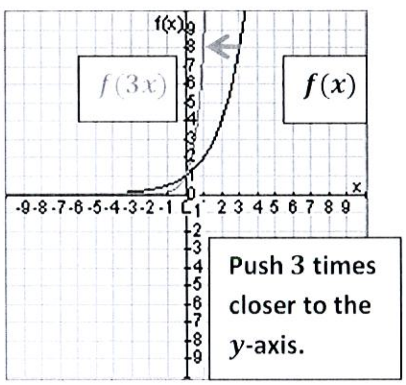
$f(x+3) = 2^{x+3}$



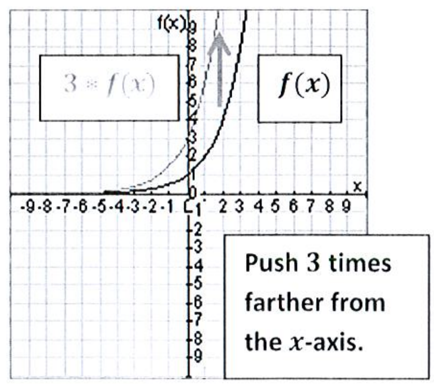
$f(x) + 3 = 2^x + 3$



$f(3x) = 2^{3x}$



$3 * f(x) = 3 * 2^x$



Notice that the same things occurred with the exponential as with linear functions. More specifically, we could develop generic forms of an exponential equation transformation given that $f(x) = b^x$. Specifically $g(x) = k * b^x$ pushes $f(x)$ farther from the x-axis k times, $g(x) = b^{kx}$ pushes $f(x)$ closer to the y-axis k times, $g(x) = b^{x+k}$ is a translation of $f(x)$ to the left k units, and $g(x) = b^x + k$ is a translation of $f(x)$ up k units.

Example Exponential Transformations

Now whether we are given something in function notation only or the full equation, we should be able to determine how the function will be transformed. For example, consider the following function notation transformations using $f(x) = \left(\frac{1}{2}\right)^x$ as the parent function.

$f(x+2)$	$f(x) - 2$	$f(2x)$	$3 * f(x)$
Translate 2 left	*Translate 2 down*	*Stretch 2 times closer to the y-axis*	*Stretch 3 times farther from the x-axis*

Now consider the following equation examples. They follow the generic form of an exponential that we just discovered. Let's again use the same parent function.

$g(x) = \left(\frac{1}{2}\right)^{x-4}$	$g(x) = \left(\frac{1}{2}\right)^x + 3$	$g(x) = \left(\frac{1}{2}\right)^{2x}$	$g(x) = 3 * \left(\frac{1}{2}\right)^x$
Translate 4 right	*Translate 3 up*	*Stretch 2 times closer to the y-axis (since no translation)*	*Stretch 3 times farther from the x-axis (since no translation)*

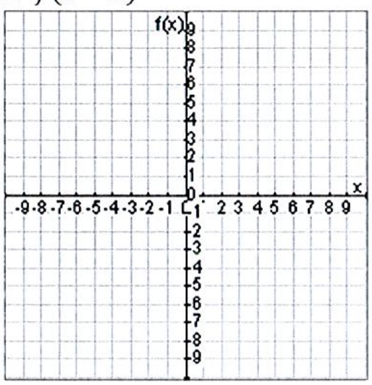
To verify these, it may be useful to graph the functions.

Lesson 4.3

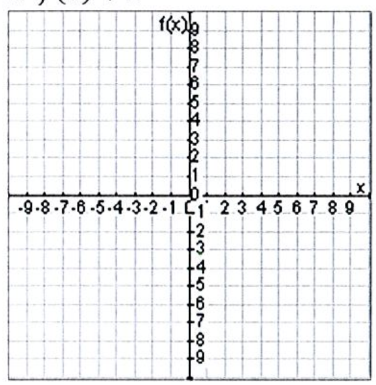
Describe the transform that occurs using the given functions. Then write the new function's equation and draw a quick sketch of the graph.

$f(x) = 2^x$ $\qquad$ $g(x) = \left(\frac{1}{2}\right)^x$ $\qquad$ $h(x) = 3^x$

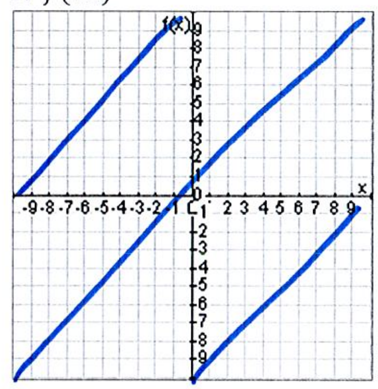
1. $f(x-2)$



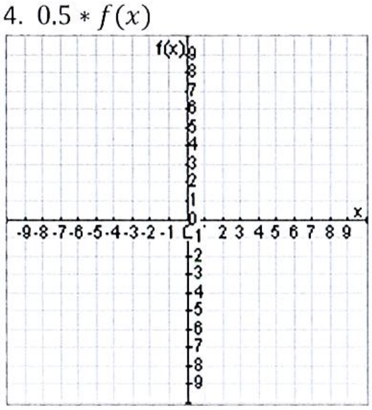
2. $f(x) + 3$



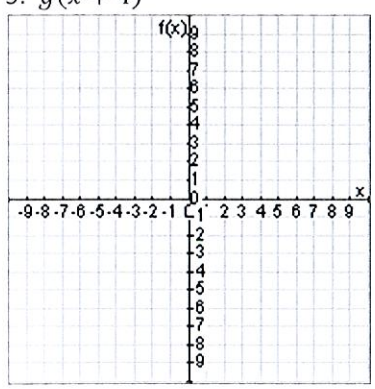
3. $f(2x)$



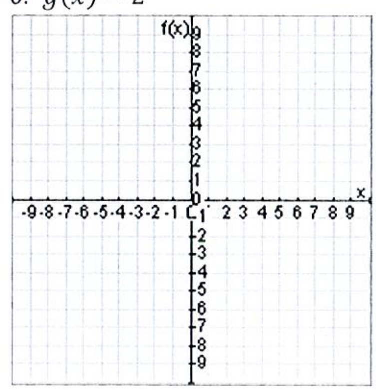
4. $0.5 * f(x)$



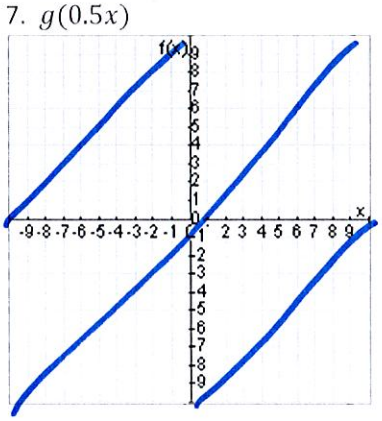
5. $g(x+4)$



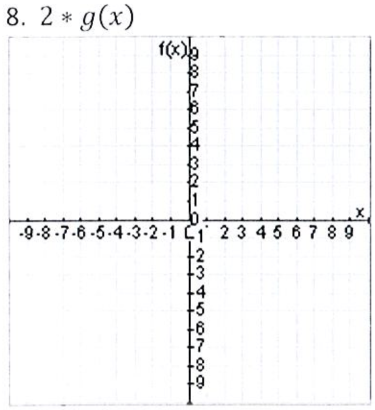
6. $g(x) - 2$



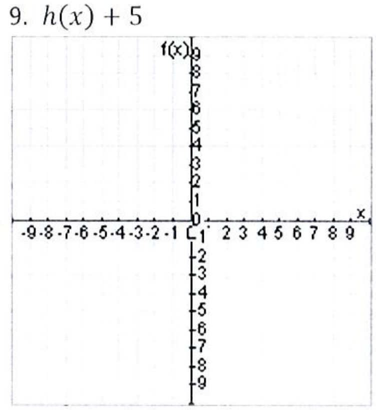
7. $g(0.5x)$



8. $2 * g(x)$

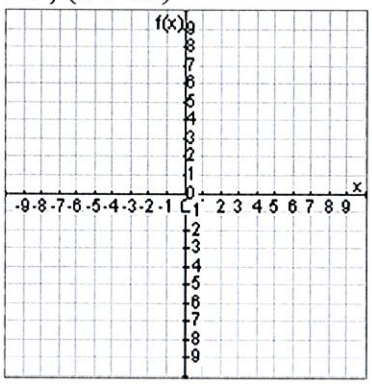


9. $h(x) + 5$

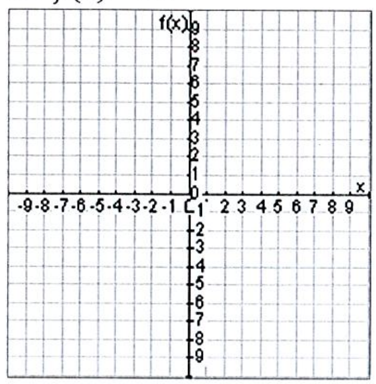


$f(x) = 2^x$ $g(x) = \left(\frac{1}{2}\right)^x$ $h(x) = 3^x$

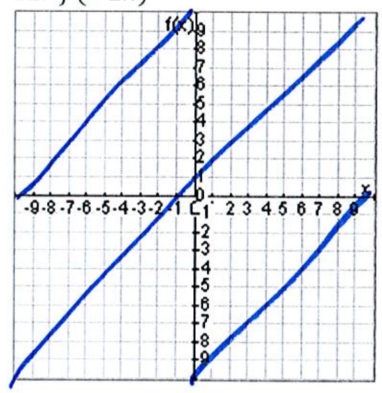
10. $f(x + 0.5)$



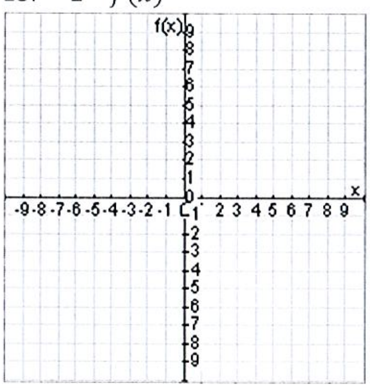
11. $f(x) - 0.5$



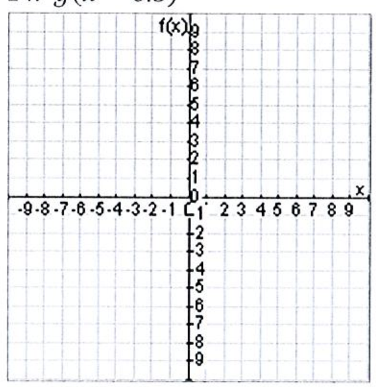
12. $f(-2x)$



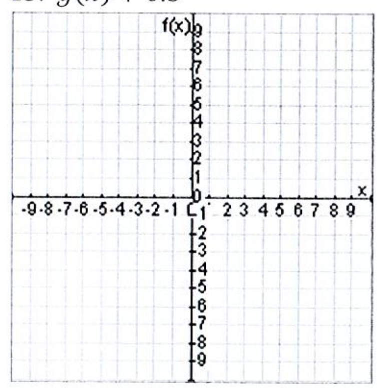
13. $-2 * f(x)$



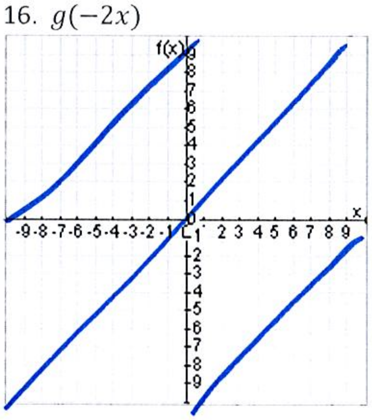
14. $g(x - 0.5)$



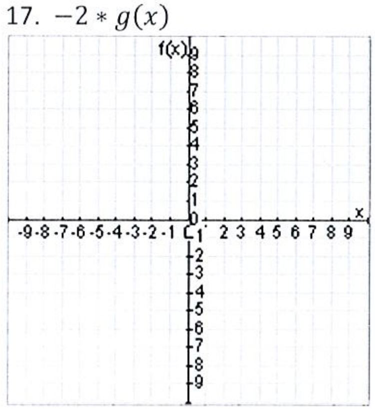
15. $g(x) + 0.5$



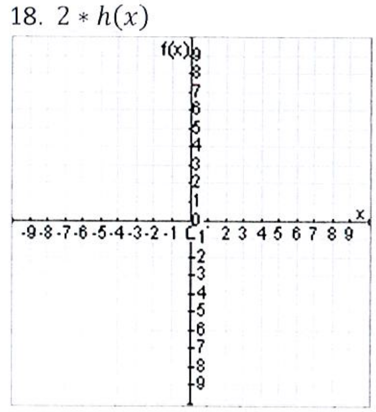
16. $g(-2x)$



17. $-2 * g(x)$

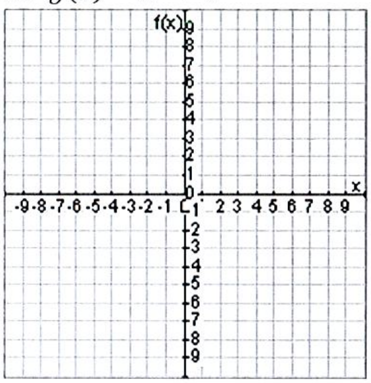


18. $2 * h(x)$

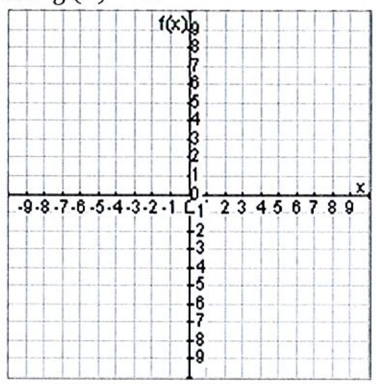


Describe the transform denoted by $g(x)$ using the function $f(x) = 2^x$ as the parent function. Write $g(x)$ in terms of $f(x)$ and then do a quick sketch of the graph of $g(x)$.

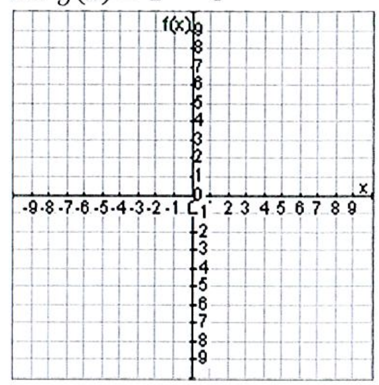
19. $g(x) = 2^x + 4$



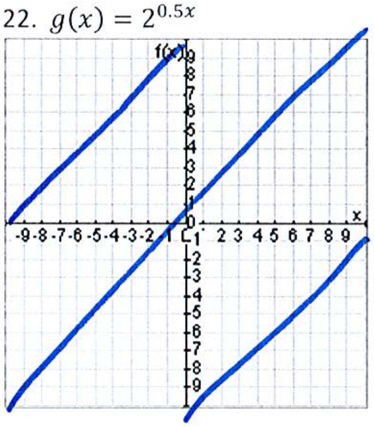
20. $g(x) = 2^{x+4}$



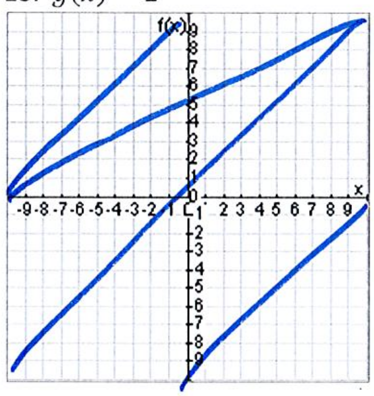
21. $g(x) = 2^x - 3$



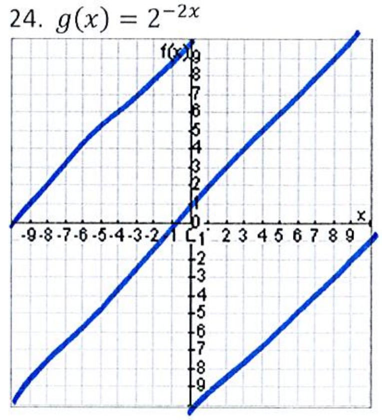
22. $g(x) = 2^{0.5x}$



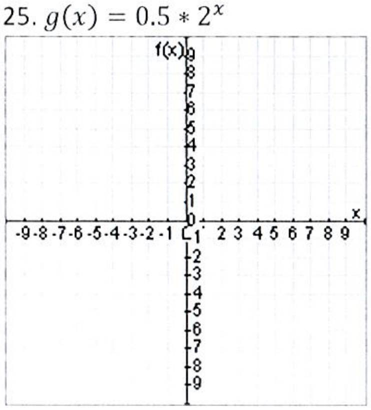
23. $g(x) = 2^{2x}$



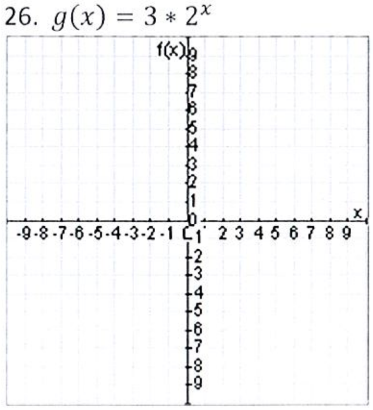
24. $g(x) = 2^{-2x}$



25. $g(x) = 0.5 * 2^x$



26. $g(x) = 3 * 2^x$



27. $g(x) = -1 * 2^x$